DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE FOR ENVIRONMENT, SAFETY AND
OCCUPATIONAL HEALTH RISK ANALYSIS (AFMC)
BROOKS AIR FORCE BASE, TEXAS

3 Jun 00

MEMORANDUM FOR 72 AMDS/SGPB

FROM: AFIERA/RSHI
2513 Kennedy Circle
Brooks AFB TX 78235

SUBJECT: Consultative Letter, IERA-RS-CL-2000- 057, Chromate Exposures During Priming Operations, Tinker AFB, OK

1. INTRODUCTION

a. *Purpose*: The MAJCOM Corrosion Managers, through the Corrosion Control Environment, Safety, and Occupational Health (ESOH) Integrated Product Team (IPT), requested the Industrial Hygiene (IH) Branch of the Air Force Institute for ESOH Risk Analysis (AFIERA/RSHI) perform surveys of several aircraft corrosion control technologies. The purpose of these surveys is to evaluate worker exposures and standardize engineering controls and protective equipment requirements for similar operations across the Air Force. As part of this evaluation, the IH Branch assessed metals exposures during the priming of a B-52 and KC-135 aircraft. The survey was done 6-10 March 2000. This consultative letter summarizes our findings.

b. *Survey Personnel*:

Capt Joseph Costantino, Industrial Hygiene Consultant
TSgt James Jarbeau, Industrial Hygiene Technician
SSgt Jason Kent, Industrial Hygiene Technician

c. *Personnel Contacted*:

Ms Teresa Wheeler, 72 AMDS/SGPB
Mr. Pete Petersen, OC-ALC/LAPCCB
Mr. Rick Golden, OC-ALC/LAPCCB

d. *Equipment Use*d:

SKC Air Sampling Pumps, field calibrated before and after sampling
Bios International Dry Cal Calibrator

2. SURVEY PROCEDURES

a. *Description of Operatio*n: Corrosion Control personnel (OC-ALC/LAPPCB) strip B-52 and KC-135 aircraft to bare metal using benzyl alcohol-based strippers and then apply an epoxy primer containing strontium chromate to the aircraft surface. After priming, workers paint the aircraft with a polyurethane topcoat. The KC-135 priming operation was limited to the leading edges, while the B-52 was a complete aircraft prime. The priming and painting operations are conducted in buildings 2280 (B-52) and 3225 (KC-135). Bldg 3225 has a crossdraft ventilation system installed, providing air movement from one end of the plane towards the other. Bldg 2280

has a semi-downdraft ventilation system, providing air movement from the ceiling towards the sides of the facility, where air is exhausted through exhaust filtration units.

b. *Source of Exposur*e: The primer contains strontium chromate as a corrosion inhibitor. Workers apply the primer with a Graco high volume-low pressure (HVLP) compressed air paint spray gun. The gun produces droplets that are propelled toward the surface of the aircraft by the force of the compressed air. Most of the droplets land on the surface and form the primer coating. Some of the droplets, however, are entrained in the air flow around the surface and become airborne, forming the paint overspray. This overspray can be transported back into the worker's breathing zone and result in chromate exposures.

c. *Health Effect*s: Chromates have been linked to occupational diseases, specifically dermatitis, nasal irritation, and lung cancer [1]. Strontium chromate is a suspected human carcinogen [2]. The current Air Force Occupational Exposure Limit (OEL) for strontium chromate is 0.5 micrograms per cubic meter of air (µg/m3) as an eight-hour time-weighted average (TWA, measured as chromium, Cr) [2,3]. OSHA regulates chromate exposures with a Permissible Exposure Limit (PEL) of 50 µg/m3 as a ceiling limit (measured as chromium) [4].

d. *Survey Protoco*l: The exposure assessment included visual observation of the operation, personal air sampling during the priming operation, and an evaluation of current engineering controls and personal protective equipment. Ten workers were monitored during the two priming operations. Sampling for chromates was conducted using a 37-mm cassette with a modified cap mounted in a holder that keeps the cassette opening perpendicular to the worker's body. The 37-mm cassette is the accepted method to measure "total" particulate exposure [5] while the modified cap allows measurement of the inhalable mass fraction [6]. This mass fraction is the part of the particle size distribution the worker will breathe into the respiratory system [2,6]. Samples were taken for the duration of the priming operations using 5-mm polyvinyl chloride filters. The Chemistry Division of AFIERA analyzed the filters using NIOSH analytical method 7600 (chromates) [5].

e. *Respiratory Protectio*n: Personnel spraying the primer wore continuous-flow loose fitting hoods. The respirators were in good repair, stored appropriately, and worn properly. The Tinker AFB Bioenvironmental Engineering Flight has received a waiver from AFMOA to use an APF of 1000 for these respirators.

f. *Work Practice*s:

(1) Corrosion personnel use a Graco paint spray gun to prime aircraft. These guns are high-volume low-pressure guns designed to operate at gun air cap pressures of 10 pounds per square inch gauge (psig). Manufacturers claim HVLP guns have higher transfer efficiencies than conventional spray guns.

(2) Workers prime the aircraft as a group. This results in a fast, efficient aircraft coating operation, but tends to generate a large amount of overspray. A heavy coating of primer is applied to the entire aircraft to ensure adequate coverage of the metal surface. Personnel wear Tyvek ® coveralls, a paint sock, and rubber gloves during the priming procedure.

3. RESULTS

a. Tables 1 and 2 show the measured task exposures (the average concentration over the length of the task) and the 8-hr TWAs for each individual monitored during this survey. Strontium chromate concentrations were calculated assuming all hexavalent chromium found in the sample is bound to strontium. This is a good assumption for priming, because chromate exposures result directly from the strontium chromate contained in the primer. All worker 8-hr TWA exposures exceeded the Air Force OEL during these priming tasks.

b. The OSHA PEL is a ceiling limit, in theory this is a limit that should never be instantaneously exceeded. As a practical matter, however, it is difficult to measure instantaneous levels of chromates, so we recommend comparing the task exposure to the PEL to determine compliance. As shown in Tables 1 and 2, priming of aircraft did result in chromate exposures in excess of the OSHA ceiling limit of 50 μg/m3.

4. DISCUSSION

a. The highest task exposure level (837 μg/m3) is 1674x the AF OEL. The current level of respiratory protection, with an APF of 1000, is only adequate up to an exposure level of 500 μg/m3. Therefore, actions need to be taken to further reduce exposures.

b. Reduction of exposures during priming requires a decrease in workplace concentrations of chromates. One reason chromate concentrations may be elevated is the application rate of primer onto the aircraft. To lower chromate concentrations, Corrosion Control personnel should reduce the primer application rate. They can do this either by decreasing the amount of primer applied to the aircraft or lengthening the time it takes to apply the primer. On a visit to Nellis AFB, personnel from the Air Force Corrosion Program Office told us the Corrosion workers there applied about three times as much primer on the aircraft as needed for corrosion protection. If it's not possible to decrease the amount of primer applied, workers should increase the application time.

c. The higher levels measured during the KC-135 operation is probably related to the operation of the ventilation system. We were told during the survey that the system was not operating at full capacity (one of the four air handling units was not working).

d. Graco has a newer air-assisted airless spray gun that could reduce exposures. Some of these newer guns have extensions that allow the worker to stand away from the paint overspray. A gun extension could be useful in reducing exposures when priming the top portion of the wings.

5. RECOMMENDATIONS

a. Full-aircraft priming operations should be modified to reduce exposures. Reference 9 lists some engineering and administrative controls that have been found to reduce chromate exposures at other facilities. These recommendations were coordinated with the Air Force Corrosion Program Office.

b. Ideally, only one worker should prime the aircraft at a time. If this is not possible, workers should avoid spraying primer while in the vicinity of other workers. For example, one worker could prime the tail while the other primes the cockpit area. Workers should not enter locations where the paint droplet cloud is still visible.

c. Reduce the primer application rate by either decreasing the amount of primer used or increasing the application time. The workers should apply the lightest acceptable coating of primer possible to the surface.

d. Workers should check air cap pressures of their spray guns prior to each use in order to limit excessive overspray generation rates. The shop should also consider using guns extensions that allow the worker to stand away from the paint overspray.

6. We appreciate the cooperation we received from both the Tinker Corrosion Control and Bioenvironmental Engineering offices during this survey. This report is located on our web site: http://sg-www.satx.disa.mil/iera/rsh/IndustrialHygiene/. Also, a new technical report will soon be available which further discusses chromate evaluations and controls during corrosion control operations. If you have any questions concerning this report, please contact the IH Branch at DSN 240-6137.

//Signed//
JOSEPH COSTANTINO, Capt, USAF, BSC
Industrial Hygiene Consultant

Attachments
1. Results
2. References

7 Mar 00			
Priming KC-135			
Bldg 3225			
		Table 1. Hexavalent chromium ($\mu g/m^3$)	
	Time (min)	Task (ug/m^3)	8-hr TWA (ug/m^3)
Worker 1	35	49.0	3.57
Worker 2	49	704.0	71.87
Worker 3	34	53.0	3.75
Worker 4	47	837.0	81.96
9 Mar 00			
Priming B-52			
Bldg 2280			
		Table 2. Hexavalent chromium ($\mu g/m^3$)	
	Time (min)	Task (ug/m^3)	8-hr TWA (ug/m^3)
Worker 5	126	256.0	67.20
Worker 6	141	9.0	2.64
Worker 7	114	222.0	52.73
Worker 8	113	386.0	87.65
Worker 9	122	50.0	12.60
Worker 10	117	165.0	39.88

References

1. R.A. Goyer, "Toxic Effects of Metals," in *Casarett and Doull's Toxicology, The Basic Science of Poisons*, 4th edition, M.O. Amdur, J. Doull, C.D. Klaassen, editors, McGraw-Hill, Inc., New York NY (1991).

2. American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for ChemicalSubstances and Physical Agents*, ACGIH, Cincinnati, OH (1996).

3. AFOSH Standard 48-8, *Controlling Exposures to Hazardous Materials*, 1 September 1997.

4. 29 CFR 1910.1000, *Air Contaminants*.

5. National Institute for Occupational Safety and Health, *NIOSH Manual of Analytical Methods*, 4th edition, NIOSH, Cincinnati, OH (1994).

6. J.H. Vincent, D. Mark, "Entry Characteristics of Practical Workplace Aerosol Samplers in Relation to the ISO Recommendations," *Annals of Occupational Hygiene*, 34(3):249-262 (1990).

7. AFOSH Standard 48-1, *Respiratory Protection Program*, 25 February 1994.

8. American Industrial Hygiene Association, *Engineering Field Reference Manual*, AIHA, Akron, OH (1984).

9. AL/OEM Consultative Letter, *Chromate Exposures During Modified Aircraft Corrosion Control Operations, Shaw AFB, SC*, AL/OE-CL-1997-0031, 30 May 1997.